

DISCUSSION OF SPECIES

Order Procellariiformes

Family Diomedidae, Albatrosses

Diomedea californica Miller (1962)

Figure 1, I

The type of *Diomedea californica* is a distal portion of tarsometatarsus (breadth of distal end 20.6 mm.), slightly larger than that of *D. albatrus* (distal breadth 19.3 mm.), but not as large as that of *D. exulans* (distal breadth 23.9 mm.). A distal end of humerus (LACM 16468) in the present collection is assigned to *D. californica* on the basis of a similar intermediate size as compared with humeri of the two Recent species noted (see Table 2).

Other than size, distinctions from the Recent species lie in less proximal extent of both the ectepicondylar prominence and the attachment of the anterior articular ligament.

A badly eroded distal end of femur (LACM 7431) is so defaced that its contours suggest either *Diomedea* or *Pelecanus*. It has the heavy proportion of shaft found in the pelicans, but I would hesitate to introduce the genus *Pelecanus* into the California Miocene record on the basis of this very questionable specimen. It is possible that it represents *Diomedea californica*.

TABLE 2

Measurements and Proportions of Albatross Humeri
(Measurements in millimeters, ratios in per cent)

	<i>D. californica</i>	<i>D. albatrus</i>	<i>D. exulans</i>
A. Greatest breadth of distal end	27.5	26.0-26.7	31.6
B. Distance from distal notch between internal condyle and entepicondyle, to proximal tip of attachment of anterior articular ligament	20.2	20.8-21.3	25.6
C. Distance from distal contour of external condyle to proximal junction of ectepicondylar process with shaft	18.2	18.8-20.7	23.0
Ratio of measurement B to measurement A	73.5	79.7-81.4	81.2
Ratio of measurement C to measurement A	66.2	71.7-77.5	72.7

***Diomedea milleri*, new species**

Figure 1, C

Type: Proximal end of left ulna, LACM 7319, collected by J. Vlastnik, March 28, 1964.

Locality and age: Sharktooth Hill, Kern County, Calif., LACM loc. 1655, sect., 25, T 285, R 28E, Oil Center Quadrangle, U.S.G.S., 1954; Middle Miocene.

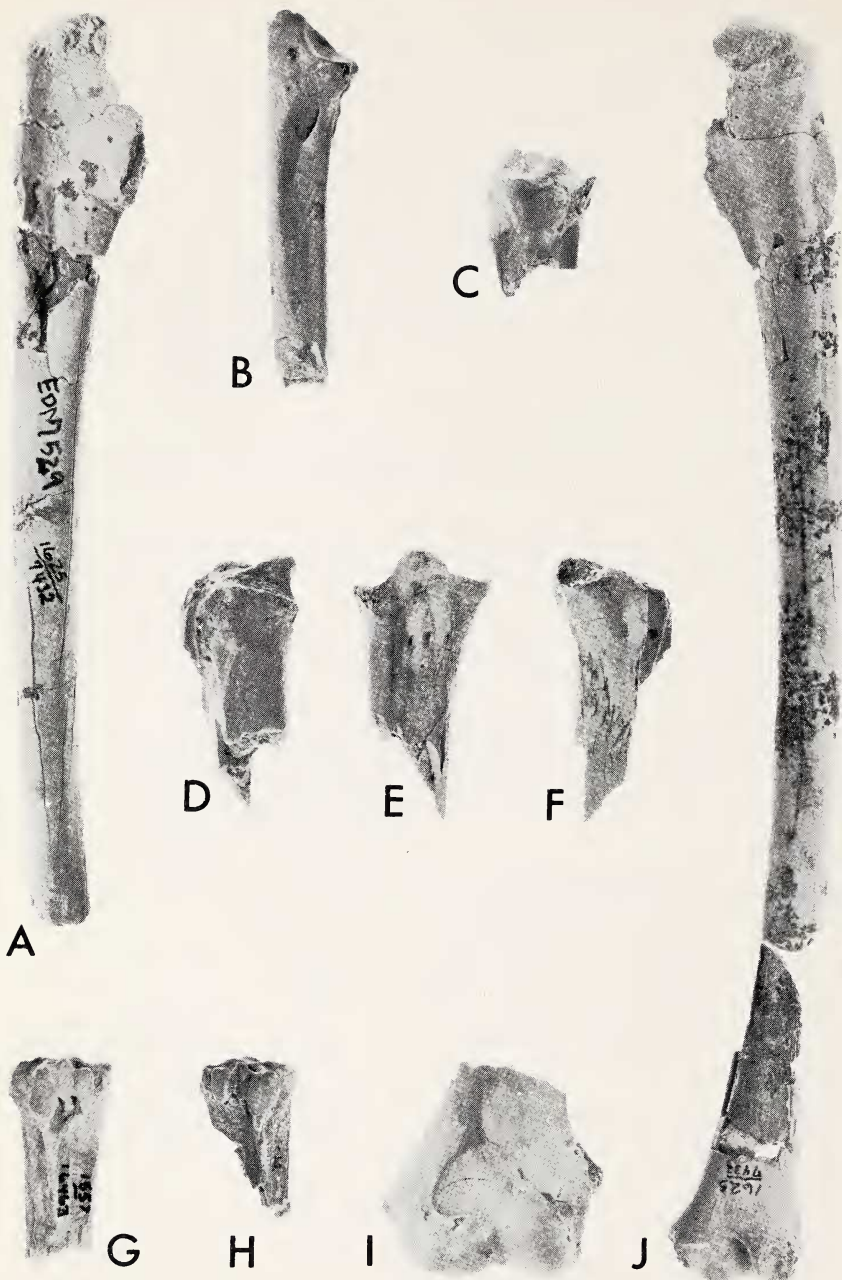


Figure 1. A, B and J, *Morus vagabundus* Wetmore: A and J, referred humerus LACM 7432, palmar view proximal section, and anconal view proximal and distal sections placed together (contact missing); B, referred ulna LACM 16473, internal view. C, *Diomedea milleri*, new species, type ulna LACM 7319, palmar view. D, E, F, *Presbychen abavus* Wetmore, referred tarsometatarsus LACM 16466, external, anterior and internal views. G, *Morus* sp. (1), right tarsometatarsus LACM 16463, posterior view. H, *Morus* sp. (2) left tarsometatarsus LACM 16464, posterior view. I, *Diomedea californica* Miller, referred humerus LACM 16467, palmar view. All figures x1.

Diagnosis: Proximal breadth of ulna across cotylae approximately 82 per cent of this dimension in *D. nigripes*; shaft below internal cotyla forming distinct angle between palmar and internal surfaces; brachial impression well depressed and distinctly delimited at its proximal tip by the prominent, broad surface of the attachment of the anterior articular ligament; the latter attachment relatively short, not extending distally beyond level of distal edge of proximal radial depression.

Measurements: See Table 3.

Referred specimen: Proximal fragment of right tarsometatarsus, LACM 16474, collected by M. K. Hammer from LACM locality 1625, Sharktooth Hill.

Compared with the tarsometatarsus of *D. nigripes*, the characters of LACM 16474 are as follows: anterior face of shaft less depressed below proximal cotylae; proximal foramina and attachment for tibialis anticus muscle more proximally placed; posteriorly, two distinct converging calcaneal ridges narrow the hypotarsal area below the proximal foramina. Broken contours make impossible a comparison of measurements with *D. nigripes*; it is obvious, however, that the fossil is smaller than in the Recent species.

Remarks: This is the smallest species of fossil albatross to be described. It is not, however, the first fossil specimen of small albatross to be recorded. Miller (1935) records an impression of carpometacarpus and wrist bones from the Miocene shale of Lomita, in the Palos Verdes Hills, Los Angeles County, California. Because of its poor preservation, the specimen was only tentatively referred to *Diomedea*, with no specific assignment. Size was given as between that of *D. nigripes* and *D. immutabilis*. Possibly the species represented is the same as here described as *D. milleri*.

The species is named in honor of Dr. Loye Miller, pioneer in California paleornithology.

TABLE 3
Measurements (in millimeters) of Albatross Ulnae

	<i>D. milleri</i> Type	<i>D. nigripes</i> LACM Bi 1268
Breadth across proximal cotylae	14.4	17.6
Depth from internal cotyla to acromion	12.6	14.7
Breadth (anconally) below cotylae at point of greatest prominence of attachment of anterior articular ligament	12.6	14.3

Family Procellariidae, Shearwaters

Puffinus priscus Miller (1961)

A distal fragment of right humerus (LACM 16469) is assigned to *Puffinus priscus* based on its resemblance to the type in shape of ectepicondylar process and height of the process above the distal end (10.1 mm. in type, 10.3 mm. in LACM 16469). Two humeral shafts, one near the distal end (LACM 16476),

the other more central, but including the tip of the deltoid crest (LACM 16475), are tentatively assigned to *P. priscus* on the basis of similarity of proportions of the shaft.

Puffinus ? inceptor Wetmore (1930)

A fragment of humerus near the proximal end (LACM 6972) represents a shearwater. The specimen lacks the head, both tuberosities, median crest and bicipital crest and most of the deltoid crest. The contour of the shaft anconally below the pneumatic fossa is preserved, and suggests that the median crest terminated closer to the angular ridge of the shaft than in Recent species of *Puffinus*. Also the attachment of the supraspinatus muscle is more medially placed and more deeply depressed. This portion of the humerus is not known in the three shearwaters recorded from Sharktooth Hill, or in the other California Miocene species, *P. diatomicus*. However, Miller (1961:400) remarks that the distal end of the humerus (the type) of *P. inceptor* differs so notably from Recent *Puffinus* that "Were it a bird in full flesh and plumage today, it would doubtless be assigned to a separate subgenus at least." The divergence of the proximal fragment now at hand from typical *Puffinus* suggests the possibility that it, too, may represent *P. inceptor*. The possibility is strengthened by the relatively stout shaft: depth 6.5 mm., breadth 3.8 mm.; the dimensions toward the distal end in the type, as given by Miller (1961:400) are 6.0 x 3.5 mm.

Order Pelecaniformes

Family Sulidae, Boobies and Gannets

Morus vagabundus Wetmore (1930)

Figure 1, A, B and J

At least seven of the nine sulid specimens in the collection can be assigned to *Morus vagabundus*. Previous records of the species include proximal and distal ends of humerus, incomplete ulna, and cranium. The following specimens are represented in the collection now at hand: proximal and distal ends of two right humeri (LACM 7432 and 16467), distal end of left humerus (LACM 13980), proximal end of left humerus (LACM 16471); two proximal ends of left ulnae (LACM 16472 and 16473), proximal end of right ulna (LACM 16470).

The distal ends of humeri conform well with the description of the type (Wetmore, 1930:89). Of two measurable specimens, one equals the type in breadth, the other is 1.1 mm. smaller. The ulnae are assigned on the basis of size, in keeping with proportions noted in Recent species; all (like the humeri) fall within the size range of *Sula leucogaster*. On the basis of these specimens, the following additional skeletal characters may be recorded for the species.

Humerus: the proximal end has more flared deltoid crest (seen in palmar view) than in Recent sulid species, and the bicipital surface is deeply grooved

at its distal edge. Anconally, the contour from the external tuberosity to the shaft is more abrupt than in Recent specimens of *Sula* or *Morus*; the shaft has greater angularity than in *Morus*, but greater breadth below the head than in *Sula*. The line of the latissimus dorsi muscle on the external side of the shaft below the deltoid crest terminates near the anconal edge of the shaft as in *Morus* (distinguished from the condition in *Sula* in which the line is more centrally placed on the shaft).

These specimens of humeri allow more definite comparison with *Sula pohli* from the Miocene of the San Fernando Valley, California, than was previously possible (Howard, 1958:10). A measurement of length can be estimated from the proximal and distal segments of specimen no. 7432, the two totalling at least 170 mm. (See Fig. 1, J). This dimension exceeds by 20 mm. or more the humeral length of *S. pohli*, although breadth of distal end is overlapping in range. Furthermore, the internal condyle in *M. vagabundus* is more distally extended.

It was previously noted (Howard, 1958:10) that size range in Recent species of sulids suggested the advisability of reviewing the relationship of *M. vagabundus* to *M. loxostylus* of the Miocene of Maryland. The additional specimens of humeri of *M. vagabundus* now at hand indicate a range downward in size from the type, and place the minimum specimen (with a distal breadth of 17.2 mm.) below the probable size range of *M. loxostylus*. In three Recent specimens of *Sula leucogaster*, measured at the Los Angeles County Museum of Natural History, the maximum is 17 per cent larger than the minimum specimen. The recorded (Wetmore, 1930:90) humerus of *M. loxostylus*, with a distal breadth of 21.1 mm., is 22 per cent larger than *M. vagabundus* humerus LACM 13980.

Ulna: The proximal ends of ulna resemble those of *Morus* rather than *Sula* in narrow, more depressed brachial impression, with upper end of impression deeply indented (there is some tendency to pneumaticity at this point, although less than in *Sula*); heavier, less pointed acromion; a depression at base of acromion; and absence of pneumatic foramen on palmar side of shaft below external cotyla.

Morus, sp.

Figure 1, G, H

Proximal ends of right and left tarsometatarsi (LACM 16463 and 16464) represent the family Sulidae, and, presumably, the genus *Morus*. Although there is considerable specific variation in this element among Recent sulids, certain characters of the hypotarsus appear to be reliable in distinguishing *Morus* from *Sula*. In *Morus* the middle calcaneal ridge does not project as far posteriorly as the internal and is bridged on a level with the external ridge; the two tendinal canals are nearly equal in size. In *Sula*, the middle and internal ridges are of approximately equal posterior extent and are bridged together by a large posterior capping; the internal canal is notably larger than the

external. Both tarsometatarsi at hand are closer to *Morus* in these characters, but differ from Recent *M. bassanus* in having a sturdier connection between the middle and internal ridges. Also, on the proximal surface of both tarsometatarsi, the intercotylar area is raised as a tuberosity as in some species of *Sula*.

In breadth of proximal end, LACM 16463 is only one millimeter broader than LACM 16464, but the posterior surfaces of the calcaneal ridges are longer and the bone is markedly deeper anteroposteriorly through the hypotarsus, even exceeding *M. bassanus* in this dimension (see Table 4). The following qualitative characters of LACM 16463 also distinguish it from LACM 16464: a diagonal line (not present in 16464) extends distally from the external calcaneal ridge to merge medianly with the internal ridge; anteriorly the external border of the shaft is narrow (slightly inflated in 16464), and a narrow flange (lacking in 16464) extends downward from the external cotyla; the outer contour of the external cotyla is straight (rounded in 16464).

TABLE 4
Measurements and Proportions of Tarsometatarsi of *Morus*
(Measurements in millimeters, ratios in per cent)

	Fossils		Recent
	<i>Morus</i> sp. (1) LACM 16463	<i>Morus</i> sp. (2) LACM 16464	<i>M. bassanus</i> LACM 18173
Breadth of proximal end	13.7	12.7	14.6
Depth of proximal end from anterior edge of internal cotyla to posterior tip of hypotarsus	14.2	12.6	13.6
Length of posterior surface of internal calcaneal ridge	7.2	5.9	8.6
Length of posterior surface of external calcaneal ridge	5.6	4.5	5.0
Ratio of depth of proximal end to breadth of proximal end	103.1	99.1	93.3
Ratio of length of posterior surface of internal calcaneal ridge to breadth of proximal end	52.5	46.5	58.9
Ratio of length of posterior surface of external calcaneal ridge to breadth of proximal end	40.9	35.4	34.2

It is obvious that two species are represented by these tarsometatarsi, and presumably one should be referred to *M. vagabundus*. The lesser anteroposterior depth of LACM 16464 suggests that this specimen is the more likely representative of that species. The other bone is possibly assignable to the same species represented by the large ulna recorded by Miller (1961:401) as *Morus* sp. Whether or not this species can be correlated with one of the large sulids recorded from other California Miocene localities (as, for example, *M. lompocanus*) must await additional evidence to determine.

Order Anseriformes

Family Anatidae

Subfamily Anserinae, geese and swans

Presbychen abavus Wetmore (1930)

Figure 1, D, E, F

A proximal end of tarsometatarsus (LACM 16466) is assigned to *Presbychen abavus*. Wetmore (1930:92-93) described this species from the Shark-tooth Hill deposits on the basis of a single distal end of tibiotarsus said to be intermediate in size between "the largest of the Canada geese and the whistling swan" (*Branta canadensis* and *Olor columbianus*); qualitative characters were also noted, in comparison with *Branta*. Compared with proportions in Recent skeletons of *O. columbianus*, the tarsometatarsus, LACM 16466, possibly represents a smaller individual than does the type tibiotarsus, but the discrepancy would be within the range of variability to be expected in anserine birds (in both of these leg elements, a difference of 19-20 per cent between maximum and minimum individuals is noted in *O. columbianus* (see table 5). Furthermore, the fossil tarsometatarsus is less flared proximally than in living geese or swans, and would, therefore, be expected to be narrower in proportion to the tibiotarsus than is the case in either *Branta* or *Olor*.

TABLE 5

Comparison of Measurements (in millimeters) of Leg Bones of
Presbychen abavus and *Olor columbianus*

	Type	<i>Presbychen abavus</i> LACM 16466	<i>Olor columbianus</i> no. in parentheses is number of speci- mens measured
Breadth of distal end of tibiotarsus	18.6	...	20.7-24.6 (4)
Breadth of proximal end of tarsometatarsus	...	18.3	21.5-25.5 (4)
Depth of internal side of shaft of tarsometatarsus	...	9.0	8.9- 9.8 ^a (2)

^a The specimens on which maximum and minimum breadth of proximal end were taken do not provide a reliable measurement of depth of shaft.

While superficially resembling the comparable element in *Branta*, the fossil tarsometatarsus exhibits notable differences, some more closely resembling characters of *Cygnus olor*, but all sufficiently significant to indicate generic distinction: (1) proximal end lacking marked internal flare of articular area; (2) anterior face of shaft deeply depressed in region of proximal foramina; (3) external border of shaft anteriorly very distinctly marked by a straight ridge running distally from anterior edge of external cotyla; (4) internal ridge of anterior face of shaft short, becoming indistinct toward level of middle of attachment of tibialis anticus muscle (somewhat as in *Cygnus olor*); (5) outer surface of internal calcaneal ridge depressed above foramen (closest to *Cygnus olor*; this area flat in *Branta* and *O. columbianus*); (6) external side

of shaft at level of distal terminus of median calcaneal ridge, deep antero-posteriorly as in swans (narrowing proximally in *Branta*). See Table 5.

A proximal fragment of femur (LACM 16465) is tentatively assigned to *P. abavus*. It is too badly eroded to show characters in detail, or to permit precise measurements, but general appearance and size place it with the Anserinae. The head is large, and upturned, the neck well defined; the anterior edge of the trochanter is blunt, lacking the upcurved, pointed tip found in *Branta* (more closely resembling the condition found in swans); the external contour of the articular end has its greatest lateral extent approximately centered with respect to anteroposterior dimensions. Like the tarsometatarsus, the femur appears to represent an individual of smaller size than does the type of *Presbychen abavus*. Miller (1961:401) records an imperfect fragment of ulna as *Branta* sp., stating "it is far too small to represent Wetmore's species" (*Presbychen abavus*). Unfortunately no reliable measurements could be provided by the specimen. Now that a tarsometatarsus and femur, distinct from living geese, yet of smaller individuals than the type of *P. abavus*, can, with reasonable certainty, be assigned to *Presbychen*, the assignment of the ulnar fragment to *Branta* is open to question.

The fact that certain characters of the tarsometatarsus here discussed resemble those of the Mute Swan, *Cygnus olor*, in contrast to the condition found in *Branta* or *Olor*, suggests a possible North American ancestral background for this group of birds. We are reminded that *Cygnus paloregonus*, a larger and closer relative of *Cygnus olor*, is a dominant species in the Pleistocene avifauna of Fossil Lake, Oregon.

COMPARISON OF CALIFORNIA'S MARINE MIOCENE AVIFAUNAS

Avian fossils have been found in more than a dozen southern California marine Miocene localities, not all of which have been recorded. The avifaunas of nine of the recorded localities are presented in comparison with that of Sharktooth Hill in Table 6. Admittedly, it is difficult to compare the dissociated fragments from Sharktooth Hill with the partial skeletons impressed in shale found in most of the other deposits. The latter specimens, although more spectacular and more revealing of proportions of one element to another, provide scant information as to the detailed characters of the articular ends, which form the chief means of identification of the Sharktooth Hill material.

Sharktooth Hill is presumably older than any of the other deposits, with the exception of the locality in Tepusquet Canyon, Santa Barbara County (Middle Miocene). All of the others are now considered to be of Late Miocene age. The distinction in age seems to be reflected in the avifaunas. In spite of the fact that Sharktooth Hill now boasts the greatest number of recorded avian taxa, the possibility of specific identity with any of the forms from the later avifaunas is entirely tentative and inconclusive (*i.e.*, small albatross, *Diomedea milleri*, and the gannet, *Morus* sp.). On the other hand, such species as *Puffinus diatomicus* and *Sula willetti*, which predominate at the Lompoc

locality and have been recorded, also, from other Late Miocene localities, are clearly lacking at Sharktooth Hill, replaced by other, ecologically similar forms.

Possibly the shearwater specimen found at the Middle Miocene Tepusquet Canyon locality (Santa Barbara Museum of Natural History specimen 319) noted by Howard (1957:1) can be correlated with *Puffinus mitchelli* of Sharktooth Hill. The wing impressions (with some fragments of bone present) clearly indicate a bird of larger size than *P. diatomicus*, and the humerus is of the same general proportions as in the type of *P. mitchelli*, with heavy ectepicondylar process. A definite assignment must await additional discoveries.

TABLE 6
Avifaunas of California Marine Miocene Localities

	Sharktooth Hill Kern County	Tepusquet Canyon Santa Barbara Co.	Lompoc, Santa Barbara Co.	Calabasas, Los Angeles Co.	Studio City, Los Angeles Co.	Sherman Oaks, Los Angeles Co.	El Sereno, Los Angeles Co.	Lomita, Los Angeles Co.	San Pedro, Los Angeles Co.	Capistrano Beach, San Diego County
<i>Diomedea californica</i>	X									
<i>Diomedea milleri</i>	X							? ^a		
<i>Puffinus inceptor</i>	X									
<i>Puffinus priscus</i>	X									
<i>Puffinus mitchelli</i>	X	? ^a								
<i>Puffinus diatomicus</i>			X			X		X	X	? ^b
<i>Oceanodroma hubbsi</i>										X
<i>Osteodontornis orri</i>		X				X				
<i>Phalacrocorax femoralis</i>				X						
<i>Sula willetti</i>			X			X		?		
<i>Sula pohli</i>					X					
<i>Morus vagabundus</i>	X									
<i>Morus lompocanus</i>			X							
<i>Morus</i> sp.	X									
<i>Miosula media</i>			X							
<i>Paleosula stocktoni</i>							X	X		
<i>Presbychen abavus</i>	X									
<i>Branta</i> sp.	X									
<i>Limosa vanrossemi</i>			X							
<i>Recurvirostra</i> sp.	X									
<i>Cerorhinca dubia</i>			X							
<i>Palaeoscinis turdirostris</i>		X								

^aTentative referral of specimens recorded but heretofore specifically unassigned.

^bTentative referral of a specimen heretofore unrecorded.

Omitted from the table are two recorded localities: (1) one at Pt. Fermin, Los Angeles County, where the only specimen was a single water-worn float pebble containing questionably identified foot bones; and (2) one at Laguna Hills, Orange County, from which the genus *Praemancalla* was recently described (Howard, 1966); this latter locality has a large avian assemblage that is yet to be identified in detail.

SUMMARY

The present study has more than doubled previous records of avian specimens known from the Sharktooth Hill deposits. Significant information gained includes the description of an extinct species of small albatross, *Diomedea milleri*, and increased knowledge of the skeletons of previously described species, *Diomedea californica*, *Morus vagabundus*, and *Presbychen abavus*.

Although ecologically the Sharktooth Hill environment presents no marked distinction from that of the Late Miocene marine localities of California, the dominant species at Sharktooth Hill are not found in the later localities; likewise the dominant forms of the Late Miocene are absent from Sharktooth Hill.

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LATE TERTIARY RADIATION OF VIPERFISHES
(CHAULIODONTIDAE) BASED ON A COMPARISON OF
RECENT AND MIOCENE SPECIES.

By JULES M. CRANE, JR.



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